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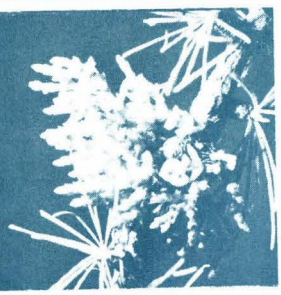

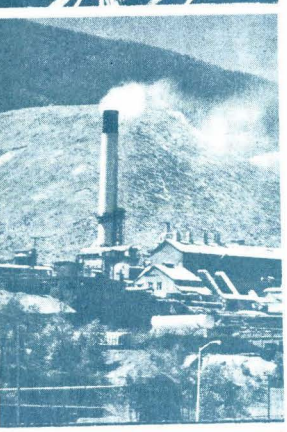

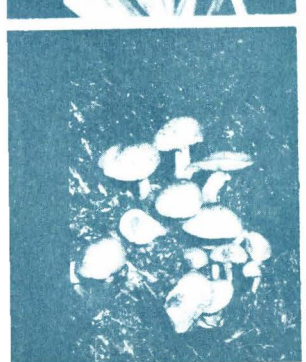

FOREST ENVIRONMENTAL PROTECTION

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5200
Report No. 76-4 March 1976

POTENTIAL FOR DEFOLIATION BY WESTERN SPRUCE BUDWORM IN DOUGLAS-FIR STANDS IN MONTANA - 1976

by

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ABSTRACT

Aerial surveys of six Montana National Forests in 1975 found a 22.1% increase in the area of visible defoliation caused by the western spruce budworm. It is estimated that 2,278,804 acres of Douglas-fir forests are now suffering at least 25% defoliation. This is an increase of 503,706 acres over the 1,775,098 acres defoliated in 1974. Egg mass surveys were made in infested areas to predict the degree of defoliation in 1976. Based on this survey, the following mean percent defoliation is predicted for each National Forest: Deerlodge, 56%; Helena, 57%; Gallatin, 29%; Beaverhead, 37%; Flathead, 5%; Lolo, 24%.

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INTRODUCTION

The western spruce budworm, *Choristoneura occidentalis* Freeman, is a native pest of Douglas-fir, *Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco; grand fir, *Abies grandis* (Dougl.) Lindl.; Engelmann spruce, *Picea engelmannii* Parry; subalpine fir, *Abies lasiocarpa* (Hook.) Nutt.; western larch, *Larix occidentalis* Nutt.; and white fir, *Abies concolor* (Gord. & Glend.) Lindl. It has been reported that western spruce budworm has caused serious defoliation on at least one National Forest Ranger District in the Northern Region annually since 1922. Generally, outbreaks last from 1 to 5 years, but in Montana 22% of the infestations persist for 6 to 15 years (Johnson & Denton 1975). On the Townsend Ranger District, Helena National Forest, for example, the budworm has been reported every year since 1925 (ibid.).

Since the budworm normally eats only the new foliage, healthy trees can usually survive several consecutive years of defoliation. Suppressed or understory trees, however, may begin to die after just one complete defoliation of the current year's growth. Widespread tree mortality may begin to occur in an infestation 3 to 5 years after it is first detected. In addition to causing mortality, defoliation may have a variety of effects on the host. The most serious effects include killing of the tree's upper crown, weakening the tree so that it is susceptible to attack by bark beetles, and reduced radial growth. Also, Dewey (1972) found that in areas where heavy defoliation occurred, nearly 100% of the Douglas-fir cones were destroyed.

The effects of defoliation on a forest-wide basis are not well documented. Bousfield et al. (1973) reported that after 5 years of heavy defoliation, 14% of a Douglas-fir stand in Montana had been top killed. Radial growth loss was estimated at 19.6 board feet per acre. Data from other surveys show that tree mortality is concentrated in the smaller size classes; i.e., less than 9 inches d.b.h., and crown damage occurring on from 4 to 33% of the stems. Damage was particularly severe to marketable Christmas trees. (Patee, R. K. 1966, and Frank et al., 1972. In Johnson & Denton 1975).

To keep land managers informed of the status of the western spruce budworm, an egg mass survey was made on six National Forests in Montana to determine potential for defoliation in 1976.

METHODS

Sample plots were taken in areas that showed visible defoliation during 1975. Usually, one plot was sampled in each of the major drainages throughout an infested area. However, some areas were inaccessible and could not be sampled. In each plot, two 30-inch branches were cut from midcrown on opposite sides of five 20- to 45-foot trees. Branch samples were placed in nylon mesh bags, transported to Missoula, and stored under refrigeration until examined.

In the laboratory, the area of foliage ($in.^2$) on each branch was determined. All old and new (1975) egg masses were removed from the foliage and separated by age class by trained observers. Only new egg masses were counted (Figure 1). The amount of current defoliation on a branch was determined by Terrell's method below.

Terrell (1966) developed a regression which correlated the number of new egg masses per thousand square inches of foliage with the percent of new growth defoliated the following year. This regression equation was used to predict the expected level of defoliation for each plot in 1976. Terrell (1966) also calculated a regression which correlates the percent of nondefoliated current shoots with the percent of current defoliation. This was used to estimate current defoliation on each plot in 1975.

RESULTS

Table 1 shows the number of acres of aerially visible defoliation in six of Montana's National Forests for 1974 and 1975. Visible defoliation increased by 503,706 acres or 22.1% to a total of 2,278,804 acres on all six National Forests (Figures 2-9).

Figure 1.--New western spruce budworm egg mass on Douglas-fir needle.

Table 1.--Acres of aerially visible[1/] western spruce budworm defoliation in Montana from 1974 to 1975.

National Forest	Acres of visible defoliation		Increase in size of infestation	
	1974	1975	Acres	Percent
Beaverhead	48,770	240,990	192,220	79.8
Deerlodge	268,237	271,629	3,392	1.2
Flathead	110,873	111,219	346	0.3
Gallatin	54,026	337,929	283,903	84.0
Helena	259,752	473,937	214,185	45.2
Lolo	1,033,440	843,100	--	--
Total	1,775,098	2,278,804	503,706	22.1

1/ Aerially visible defoliation occurs when 25% or more of the current foliage is consumed.

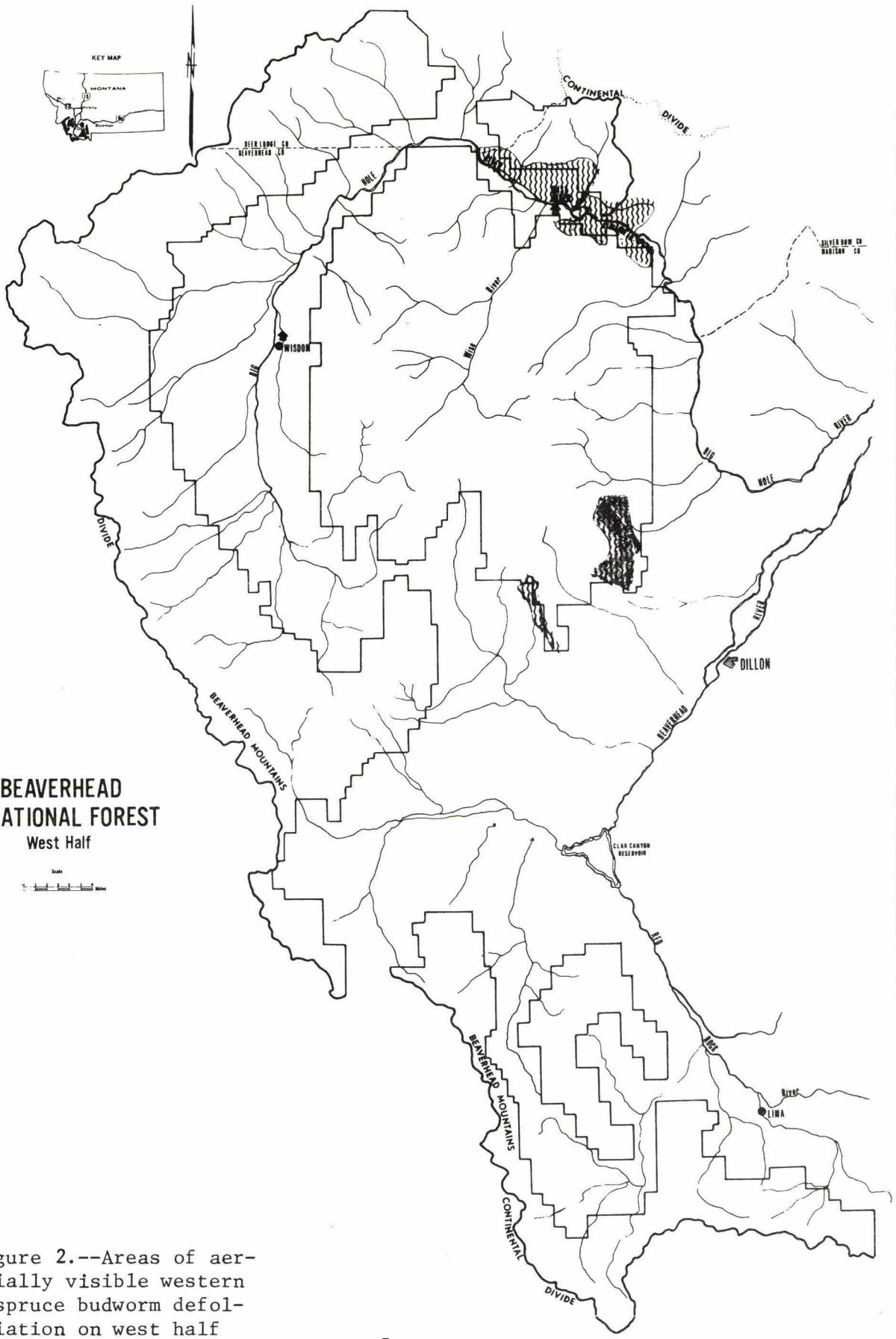

Figure 2.--Areas of aerially visible western spruce budworm defoliation on west half Beaverhead National Forest 1975.

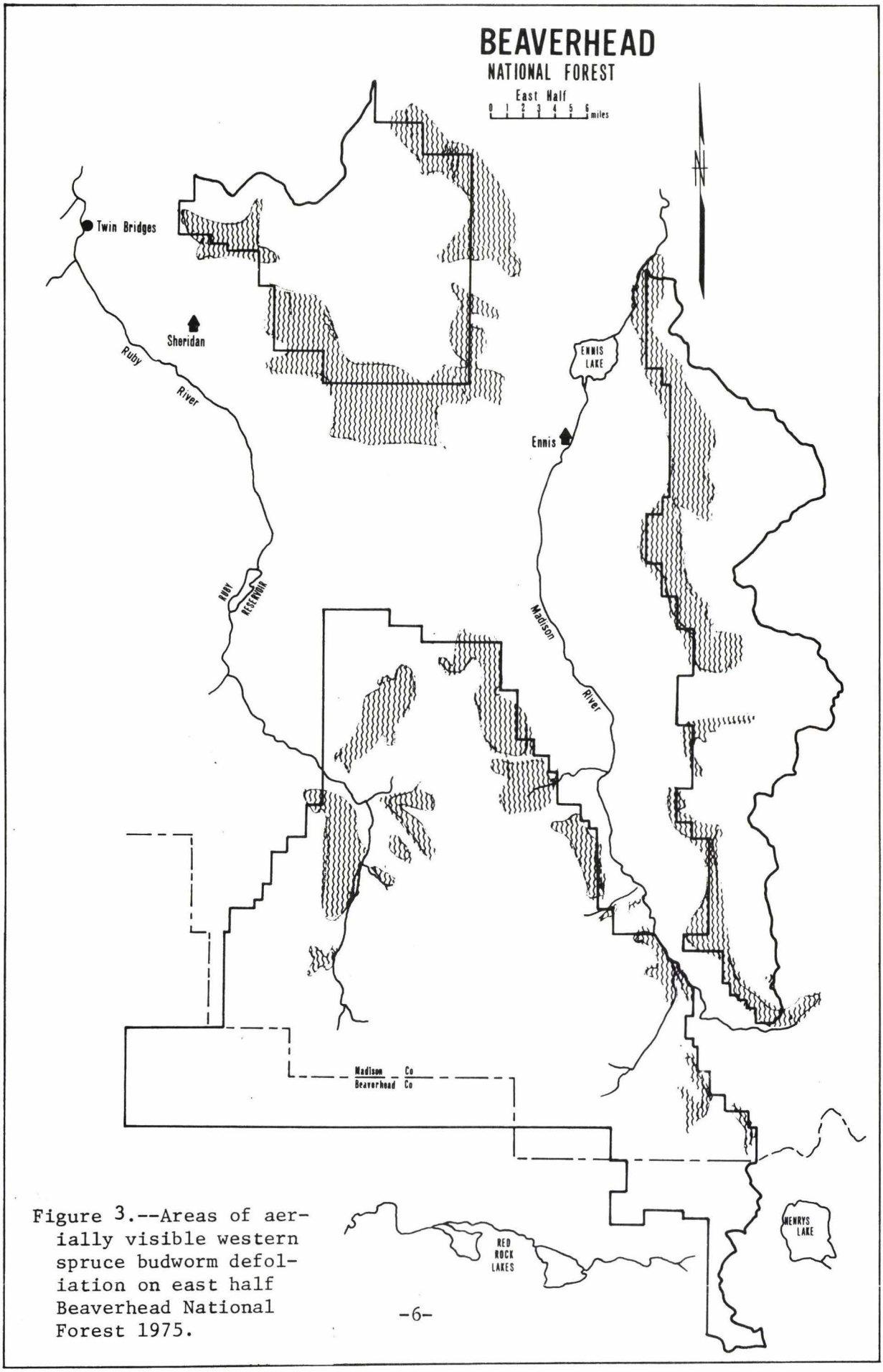

Figure 3.--Areas of aerially visible western spruce budworm defoliation on east half Beaverhead National Forest 1975.

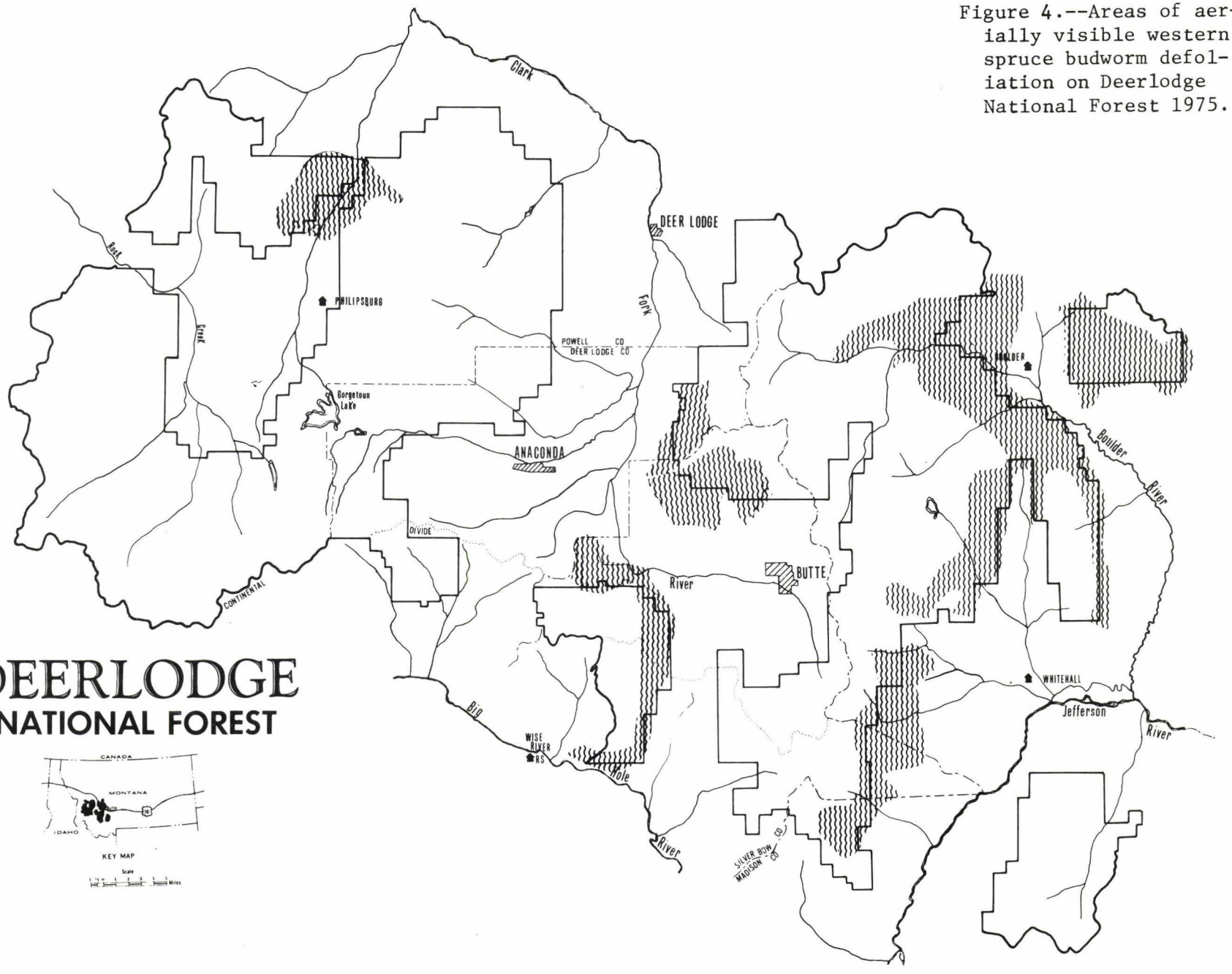

Figure 4.--Areas of aerially visible western spruce budworm defoliation on Deerlodge National Forest 1975.

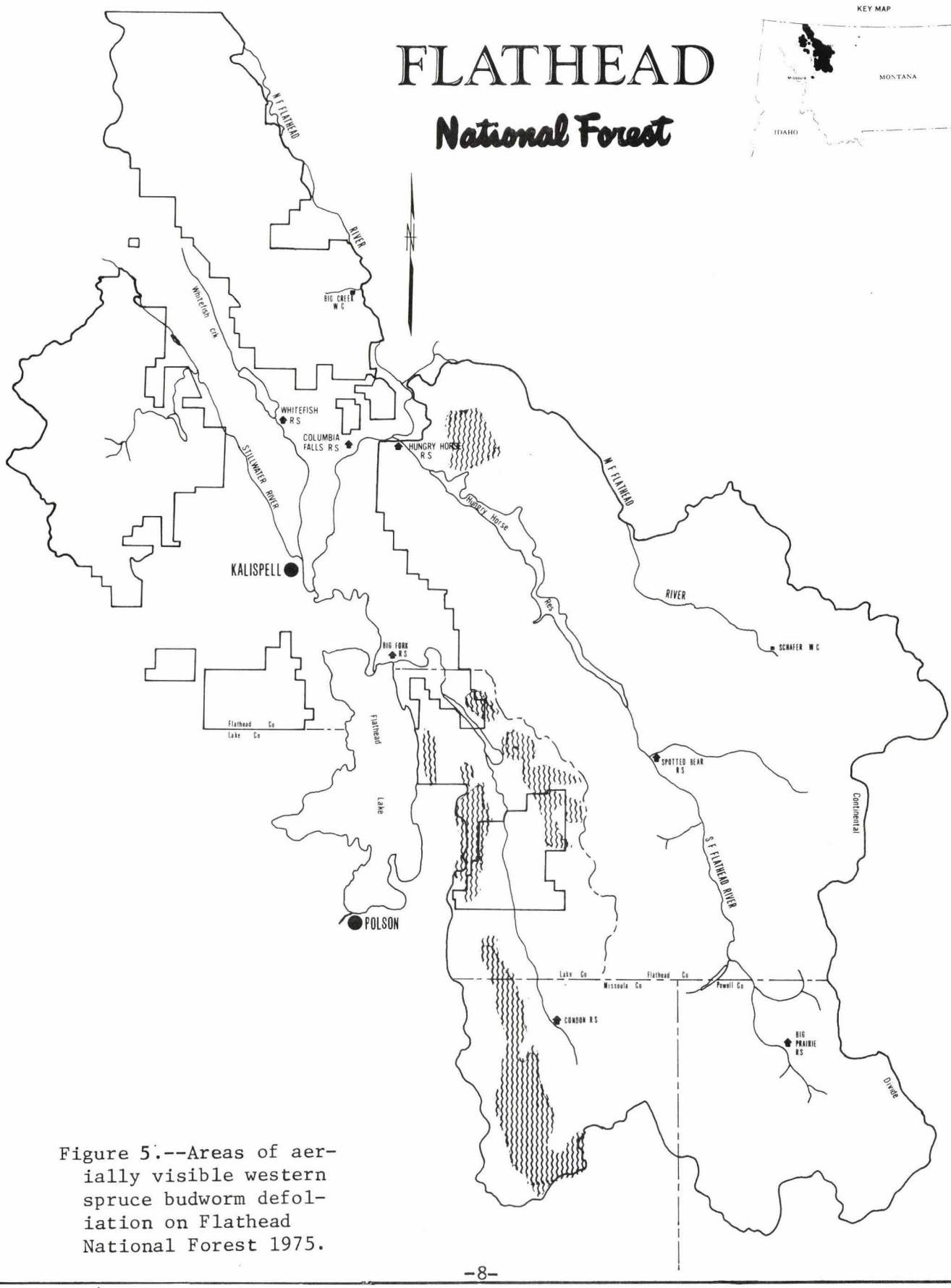

Figure 5.--Areas of aerially visible western spruce budworm defoliation on Flathead National Forest 1975.

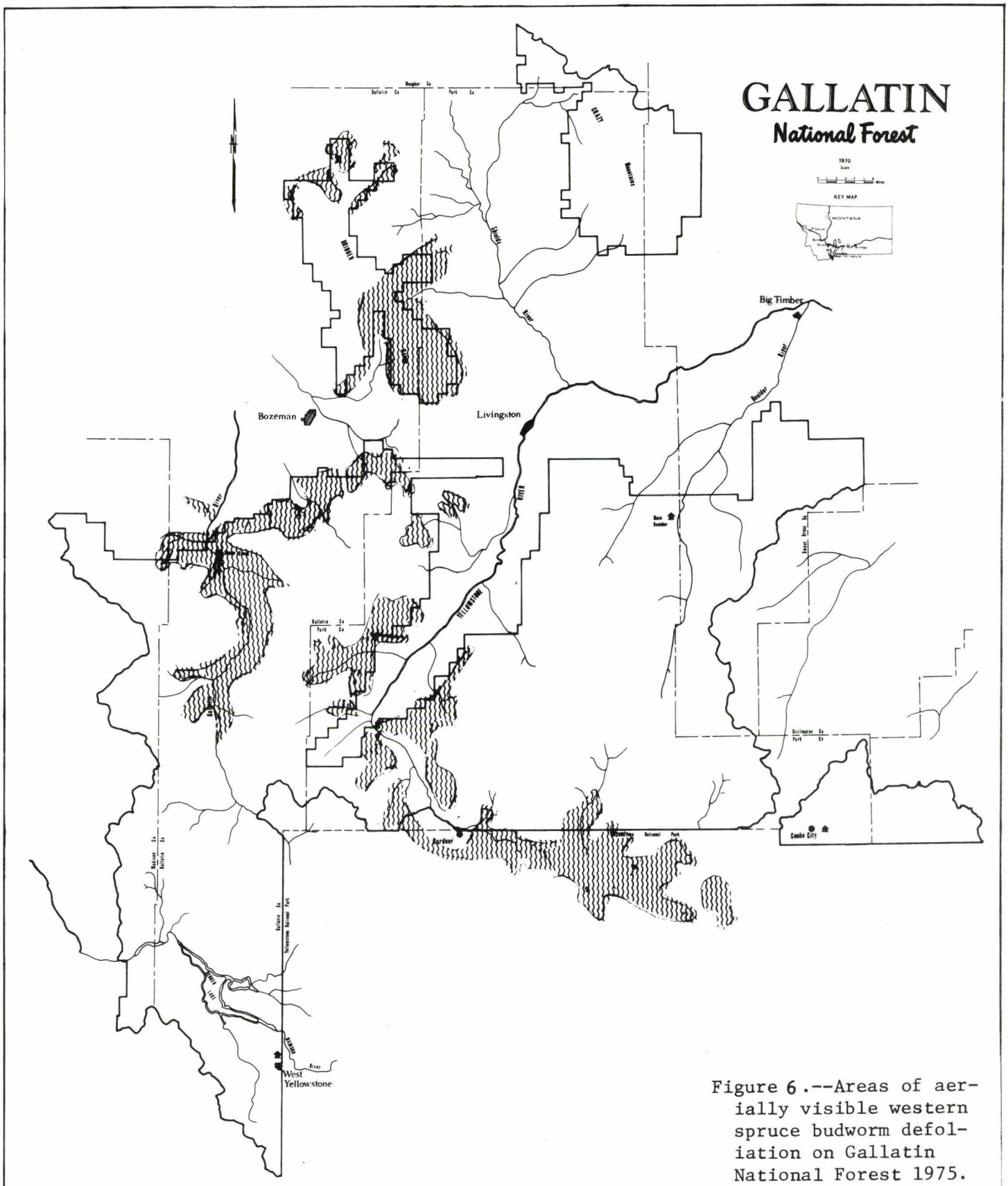

Figure 6.--Areas of aerially visible western spruce budworm defoliation on Gallatin National Forest 1975.

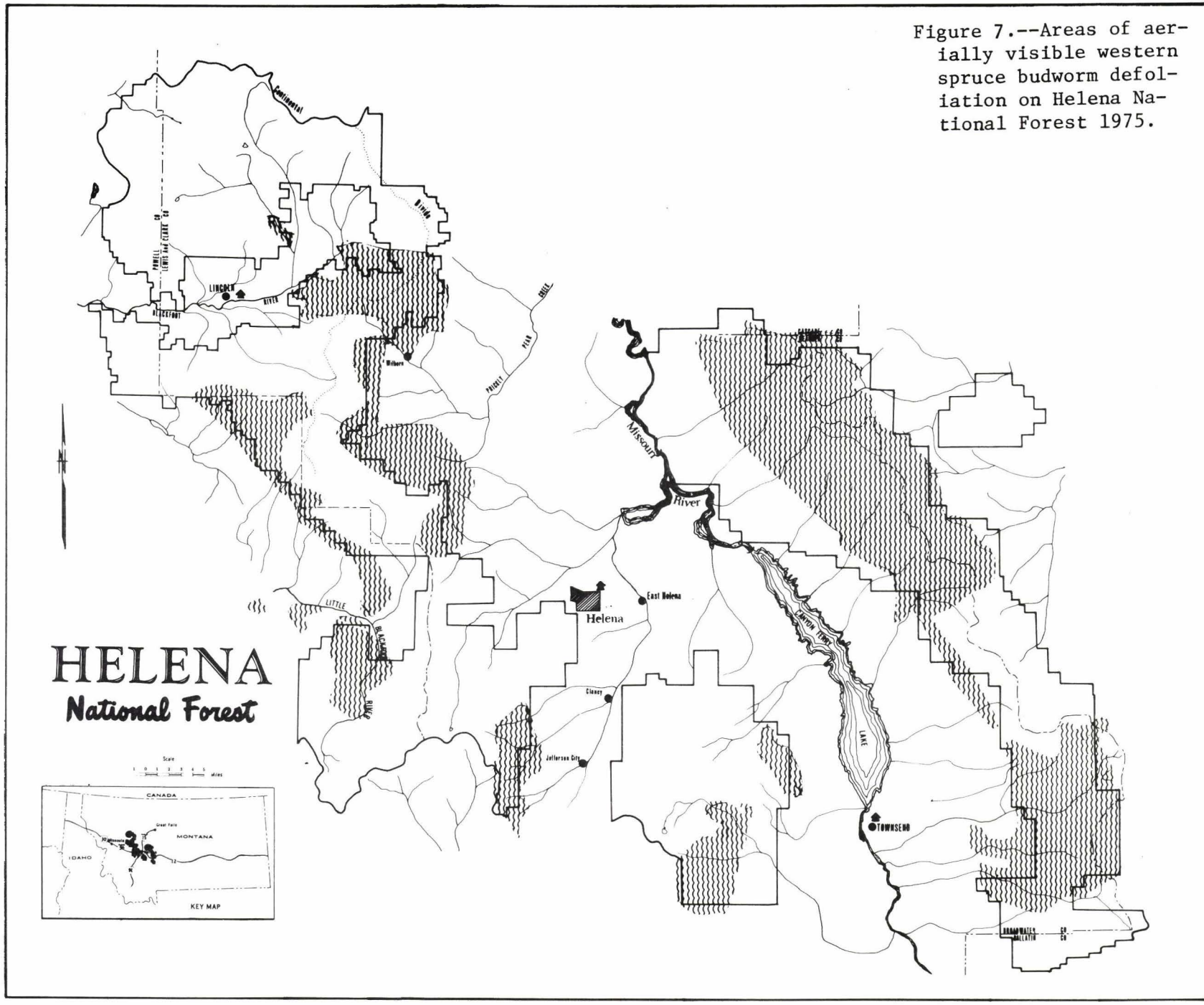

Figure 7.--Areas of aerially visible western spruce budworm defoliation on Helena National Forest 1975.

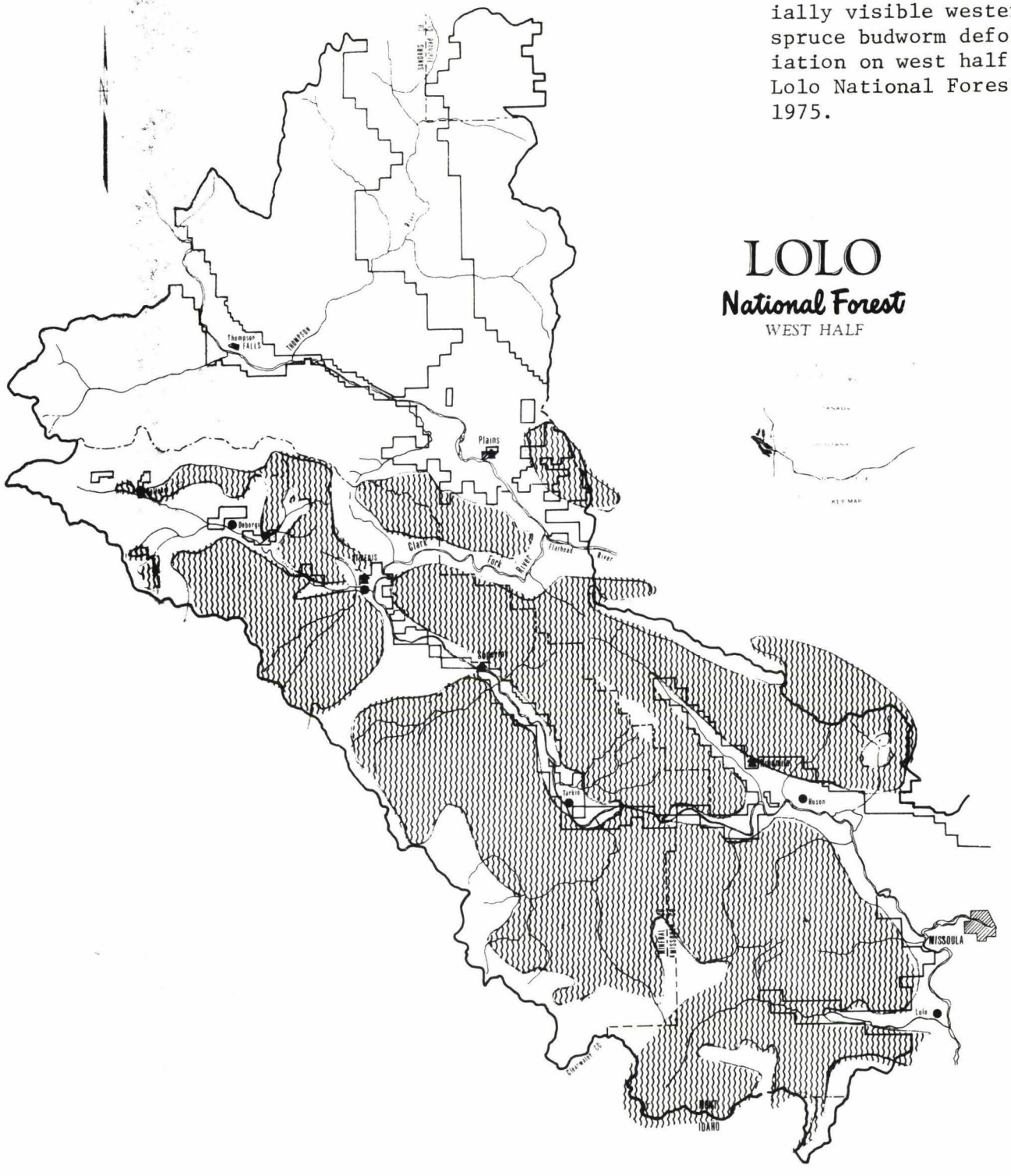

Figure 8.--Areas of aerially visible western spruce budworm defoliation on west half Lolo National Forest 1975.

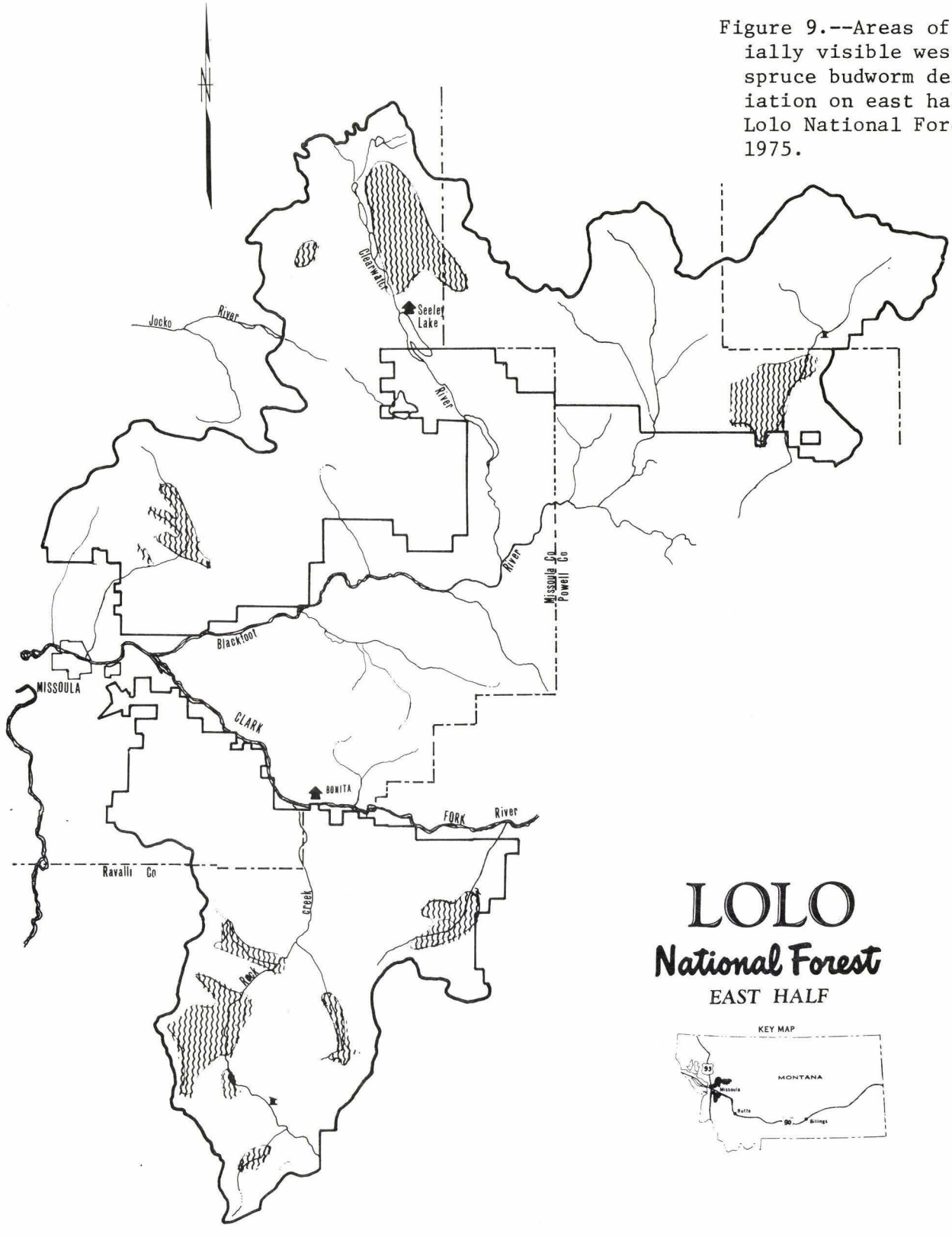

Figure 9.--Areas of aerially visible western spruce budworm defoliation on east half Lolo National Forest 1975.

Beaverhead National Forest

Acres of visible defoliation increased 79.8% from 1974 to 1975 on the Forest (Table 1) and some top kill is occurring in pole stands (Figure 10).

Figure 10.--Douglas-fir sapling top killed by western spruce budworm.

Current defoliation on 19 sample plots averaged 70.3% (range 20.2 to 81.0+%) and predicted defoliation for 1976 averaged 37% (range 0 to 79%) (Table 2). In general, defoliation was heavy throughout the infested areas on the Beaverhead and will be again in 1976.

Deerlodge National Forest

There was a small increase of about 3,392 acres of visible defoliation from 1974 to 1975 (Table 1) on the Deerlodge National Forest. However, defoliation has been getting heavier in some areas on this Forest for the past several years and top killing of understory trees is evident. Current defoliation on 20 sample plots averaged 71.8% (range 22.4 to 81.0+%) and predicted defoliation for 1976 averaged 56% (range 20 to 80%) (Table 2). Defoliation on the plots is expected to remain at about the same level in 1976.

Flathead National Forest

The budworm infestation on the Flathead seems to be decreasing. Acres of visible defoliation increased slightly but only by 0.3% (Table 1). Current defoliation on four sample plots averaged 30.6% (range 7.7 to 54.7%) and predicted defoliation for 1976 averaged 5% (range 0 to 5%) (Table 2). Defoliation in 1976 will probably range from 5 to 50% over the Forest.

Gallatin National Forest

The outbreak on this Forest seems to be subsiding despite the fact that the number of acres of visible defoliation increased from 54,026 in 1974 to 337,929 in 1975 (an 84.0% increase) (Table 1). Current defoliation on 37 sample plots averaged 62.8% (range 8.8 to 81.0+%). However, predictions for 1976 showed defoliation decreasing to an average of 29% (range 0 to 75%) (Table 2). Predicted defoliation was less than half the 1975 level on 20 out of 37 plots sampled. This, and the spotty nature of the infestation seems to support the conclusion that the budworm population in this area is now on a downward trend.

Helena National Forest

The infestion trend is upward on the Helena. Visible defoliation increased by 214,185 acres, up 45.2% from 1974 (Table 1). Current defoliation on 18 sample plots averaged 74.5% (range 16.9 to 81.0+) and predicted defoliation for 1976 averaged 57% (range 5 to 79%) (Table 2). Defoliation in 1976 will probably be higher on each of the plots than predicted in Table 2.

Lolo National Forest

The long-standing outbreak on the Lolo is decreasing. There was a decrease of 190,340 acres of visible defoliation in 1975 (Table 1). However, defoliation was lighter in the Douglas-fir type. The heaviest defoliation in 1975 was observed in stringers of true fir and spruce along creek bottoms and higher ridges.

Current defoliation on 22 sample plots averaged 43.3% (range 10.3 to 81.0+%) and predicted defoliation for 1976 averaged 24% (range 0 to 68%) (Table 2). In general, defoliation in 1976 should be about the same as 1975 on the plots.

Table 2.--Current and potential defoliation in 1976 on western spruce budworm plots in Montana.

Plot area	Plot location	New egg masses per 1,000 sq. in. foliage	Current defoliation (%)	Predicted defoliation in 1976 (%)
	Deerlodge NF			
S. Boulder R.	T. 2S., R. 3W., Sec. 6	24.0	30.2	58
Hells Canyon	T. 2S., R. 6W., Sec. 7	5.6	80.3	20
Bald Mountain	T. 1N., R. 6W., Sec. 3	8.5	62.4	27
Toll Canyon	T. 1N., R. 6W., Sec. 19	19.0	81.0+	50
Fleecer	T. 1N., R. 9W., Sec. 8	8.6	61.2	28
Dunn Canyon	T. 3N., R. 3W., Sec. 9	7.8	27.1	25
Gillespie Creek	T. 3N., R. 5W., Sec. 21	24.3	81.0+	57
Delmoe	T. 3N., R. 6W., Sec. 26	19.7	81.0+	50
McCleery Gulch	T. 3N., R. 9W., Sec. 30	2.0	75.5	9
Whitetail Creek	T. 4N., R. 5W., Sec. 25	18.7	53.2	50
Telegraph Gulch	T. 4N., R. 8W., Sec. 8	9.5	66.0	29
Whitetail Cr. Pass	T. 5N., R. 4W., Sec. 28	58.3	81.0+	80
Dry Cottonwood	T. 5N., R. 8W., Sec. 6	8.2	72.7	25
Dry Creek	T. 6N., R. 2W., Sec. 29	20.3	81.0+	80
Elkhorn Creek	T. 6N., R. 3W., Sec. 22	41.6	81.0+	74
Basin Creek	T. 6N., R. 5W., Sec. 7	34.1	76.8	69
High Ore Creek	T. 6N., R. 5W., Sec. 11	48.0	81.0+	77
Galena Gulch	T. 6N., R. 5W., Sec. 27	33.4	81.0+	68
Dry Cottonwood Cr.	T. 6N., R. 9W., Sec. 35	5.6	50.1	20
Smart Creek	T. 8N., R.13W., Sec. 6	21.2	22.4	54
Average		22.1	71.8	56
	Helena NF			
Johnny Gulch	T. 6N., R. 1W., Sec. 31	18.6	81.0+	49
Greyson Creek	T. 6N., R. 4E., Sec. 24	27.1	81.0+	62
Hay Creek	T. 6N., R. 5E., Sec. 9	17.2	81.0+	45
Cabin Gulch	T. 7N., R. 4E., Sec. 12	39.3	78.9	73
Deep Creek	T. 7N., R. 5E., Sec. 22	8.5	81.0+	25
Clancy Creek	T. 7N., R. 4W., Sec. 8	48.3	81.0+	78
Duck Creek	T. 8N., R. 3E., Sec. 2	53.0	81.0+	79
S. of Elliston	T. 9N., R. 6W., Sec. 30	32.1	81.0+	67
White Gulch	T.10N., R. 2E., Sec. 1	19.1	81.0+	48
Mullan Pass	T.10N., R. 6W., Sec. 2	12.8	81.0+	39
Magpie Creek	T.11N., R. 1E., Sec. 3	16.5	81.0+	45
Marsh Creek	T.12N., R. 7W., Sec. 1	23.9	74.9	58
Nevada Creek	T.12N., R. 8W., Sec. 22	5.8	50.7	20
Indian Creek	T.12N., R. 1E., Sec. 7	8.0	81.0+	27
Pike Creek	T.13N., R. 1E., Sec. 30	22.9	81.0+	57

Table 2.--Current and potential defoliation in 1976 on western spruce budworm plots in Montana, con.

Plot area	Plot location	New egg masses per 1,000 sq. in. foliage	Current defoliation (%)	Predicted defoliation in 1976 (%)
	Helena NF, con.			
Virginia Creek	T.13N., R. 7W., Sec. 12	0.4	16.9	5
Flesher Pass	T.14N., R. 6W., Sec. 15	44.1	67.1	75
Canyon Creek	T.14N., R. 6W., Sec. 34	41.3	81.0+	73
Average		24.4	74.5	57
	Gallatin NF			
Brackett Creek	T. 1N., R. 7E., Sec. 2	6.5	66.0	20
Battle Ridge	T. 2N., R. 7E., Sec. 32	1.9	8.8	8
Elkhorn Ridge	T. 3N., R. 6E., Sec. 13	13.9	70.5	40
Hatfield Mountain	T. 4N., R. 6E., Sec. 10	1.9	20.1	8
Hyalite Creek	T. 3S., R. 5E., Sec. 25	19.1	81.0+	47
Big Bear Creek	T. 3S., R. 5E., Sec. 32	28.3	81.0+	63
Hyalite Creek	T. 3S., R. 6E., Sec. 32	6.0	48.8	21
Bear Canyon	T. 3S., R. 7E., Sec. 6	4.6	31.6	18
Meadow Creek	T. 3S., R. 8E., Sec. 20	4.7	19.7	19
Spanish Creek	T. 4S., R. 4E., Sec. 18	12.4	79.6	36
Squaw Creek	T. 4S., R. 4E., Sec. 33	19.3	81.0+	50
Squaw Creek	T. 4S., R. 4E., Sec. 36	0	81.0+	0
Mica Creek	T. 5S., R. 4E., Sec. 1	2.9	81.0+	15
Smith Creek	T. 5S., R. 5E., Sec. 5	5.3	81.0+	18
West Creek	T. 5S., R. 5E., Sec. 6	6.7	81.0+	25
French Creek	T. 5S., R. 5E., Sec. 9	3.1	52.9	12
Greek Creek	T. 5S., R. 5E., Sec. 18	2.5	81.0+	9
Swan Creek	T. 5S., R. 5E., Sec. 30	18.0	70.8	46
Swan Creek	T. 5S., R. 5E., Sec. 30	27.7	81.0+	62
N. Fork Gallatin R.	T. 6S., R. 3E., Sec. 26	3.3	28.9	17
Middle Fk. Gallatin R.	T. 6S., R. 3E., Sec. 34	.8	9.7	5
Karst Ranch	T. 6S., R. 4E., Sec. 1	9.0	74.1	30
Portal Creek	T. 6S., R. 4E., Sec. 13	19.7	81.0+	51
Main Gallatin River	T. 6S., R. 4E., Sec. 33	10.5	70.2	29
Moose Creek	T. 6S., R. 5E., Sec. 5	4.2	80.3	15
Moose Creek	T. 6S., R. 5E., Sec. 6	8.2	81.0+	26
Portal Creek	T. 6S., R. 5E., Sec. 19	1.9	17.5	8
Beaver Creek	T. 7S., R. 4E., Sec. 32	1.4	48.2	5
Miner Creek	T. 7S., R. 6E., Sec. 35	8.2	60.2	26
Red Cliff Campground	T. 8S., R. 4E., Sec. 4	42.5	81.0+	75
Cinnamon Creek	T. 8S., R. 4E., Sec. 28	1.3	17.7	6
Yankee Jim Canyon	T. 8S., R. 7E., Sec. 4	29.8	81.0+	65
Cinnabar Basin	T. 8S., R. 7E., Sec. 28	28.1	81.0+	63
Mol Heron Creek	T. 9S., R. 7E., Sec. 3	5.9	73.4	21

Table 2.--Current and potential defoliation in 1976 on western spruce budworm plots in Montana, con.

Plot area	Plot location	New egg masses per 1,000 sq. in. foliage	Current defoliation (%)	Predicted defoliation in 1976 (%)
	Gallatin NF, con.			
Mol Heron Creek	T. 9S., R. 7E., Sec. 10	15.5	81.0+	43
Jardine	T. 9S., R. 9E., Sec. 9	25.9	78.9	61
Jardine	T. 9S., R. 9E., Sec. 10	4.6	81.0+	19
Average		10.9	62.8	29
	Beaverhead NF			
Jerry Creek	T. 1N., R.10W., Sec. 19	4.1	81.0+	14
N. of Wise River	T. 1N., R.11W., Sec. 13	2.6	81.0+	12
S. of Pony	T. 3S., R. 2W., Sec. 6	50.2	81.0+	79
N. Meadow Creek	T. 3S., R. 2W., Sec. 29	5.1	81.0+	19
Lower N. Meadow Cr.	T. 3S., R. 2W., Sec. 33	9.4	78.9	29
Willow Creek	T. 4S., R.10W., Sec. 28	.6	21.5	5
Granite Creek	T. 5S., R. 3W., Sec. 26	12.5	57.0	37
California Creek	T. 5S., R. 3W., Sec. 8	8.9	81.0+	30
Birch Creek	T. 5S., R.10W., Sec. 8	0	20.2	0
Birch Creek	T. 5S., R.10W., Sec. 9	6.7	63.4	24
Barton Gulch	T. 7S., R. 4W., Sec. 23	27.6	76.3	62
Call Road	T. 8S., R. 2W., Sec. 11	9.9	81.0+	31
Timber Creek	T. 8S., R. 3W., Sec. 26	13.9	81.0+	40
Lower Johnny Ridge	T. 9S., R. 1W., Sec. 8	13.8	74.0	40
Wall Creek	T. 9S., R. 1W., Sec. 35	20.0	64.4	51
Broomtail Ridge	T. 9S., R. 2W., Sec. 13	8.2	69.7	27
Lower Timber Creek	T. 9S., R. 3W., Sec. 9	10.7	81.0+	32
Warm Spring Creek	T. 9S., R. 3W., Sec. 22	24.6	81.0+	59
Vigilante	T. 9S., R. 3W., Sec. 29	11.4	81.0+	33
Average		12.6	70.3	37
	Flathead NF			
Lindbergh Lake	T.19N., R.17W., Sec. 22	0	7.7	0
Porcupine Creek	T.24N., R.18W., Sec. 16	.9	16.5	5
N. Fork Lost Creek	T.25N., R.17W., Sec. 28	.4	54.7	5
Emery Creek	T.31N., R.18W., Sec. 32	0	43.5	0
Average		0.3	30.6	5

Table 2.--Current and potential defoliation in 1976 on western spruce budworm plots in Montana, con.

Plot area	Plot location	New egg masses per 1,000 sq. in. foliage	Current defoliation (%)	Predicted defoliation in 1976 (%)
	Lolo NF			
Mormon Creek	T.11N., R.20W., Sec. 8	1.8	39.2	8
Marshall Creek	T.11N., R.22W., Sec. 2	.2	10.3	5
Petty Creek	T.13N., R.23W., Sec. 2	7.2	69.1	23
Fish Creek	T.14N., R.25W., Sec. 27	16.7	79.6	47
Sheridan Creek	T.15N., R.24W., Sec. 16	6.0	7.6	20
N. Fork Blackfoot R.	T.16N., R.11W., Sec. 35	.9	20.8	5
Cottonwood Creek	T.16N., R.13W., Sec. 21	8.3	55.7	26
Sixmile Creek	T.16N., R.21W., Sec. 32	.8	29.7	5
Butler Creek	T.16N., R.22W., Sec. 19	4.3	81.0+	14
W. Side Ninemile Road	T.16N., R.24W., Sec. 13	2.5	11.7	13
Cedar Creek	T.16N., R.27W., Sec. 14	31.5	65.2	68
Big Blue Creek	T.17N., R.23W., Sec. 30	6.7	20.1	24
Siegel Pass	T.17N., R.24W., Sec. 6	8.1	20.4	26
Johnson Creek	T.17N., R.25W., Sec. 29	10.7	52.6	34
Sloway Gulch	T.18N., R.26W., Sec. 19	8.9	69.4	29
St. Regis	T.18N., R.28W., Sec. 25	21.1	81.0+	52
Ward Creek	T.18N., R.29W., Sec. 17	4.9	24.9	17
McLaughlin Creek	T.19N., R.25W., Sec. 13	3.4	31.9	14
Combest Creek	T.19N., R.26W., Sec. 34	12.2	40.2	37
Tamarack Creek	T.19N., R.27W., Sec. 18	5.9	58.4	20
E. Fork Twelvemile Cr.	T.19N., R.28W., Sec. 32	8.0	70.0	24
Twelvemile Creek	T.20N., R.29W., Sec. 36	0	15.0	0
Average		7.7	43.3	24

DISCUSSION

On the Helena National Forest, 15 of the 18 plots sampled in 1975 were in the same spots sampled during 1974 (Tunnock et al, 1975). Table 3 compares differences between predicted and current defoliation in 1975 on the 15 plots. It indicated Terrell's formula (1966) predicts defoliation on the conservative side. On all 15 plots, predicted defoliation for 1975 was lower than current defoliation. Therefore, in making predictions, one has to estimate more defoliation the next year than is computed.

The outbreak on the Beaverhead National Forest is increasing and additional acres will be infested in 1976. Most of the plots sampled in 1975 are expected to be heavily (60%) defoliated in 1976. There will probably be only a slight increase in the number of acres infested in 1976 on the Deerlodge National Forest because budworm populations have been in a static stage for several years. Defoliation on the plots should be heavy

in 1976 but not greater than in 1975. Defoliation on the Flathead National Forest is decreasing and should be about the same in 1976 as it was in 1975. Budworm populations on the Gallatin National Forest exploded this year, but there was heavy natural mortality from weather, competition for food, and parasites. There will be an increase in the number of acres infested in 1976, but defoliation will probably be lighter than it was in 1975. There is an increasing infestation trend on the Helena National Forest. Average defoliation should be around 60% in 1976. Acres of visible defoliation may decrease in 1976 on the Lolo National Forest because the outbreak is showing a decreasing trend. There should be about the same degree of defoliation in 1976 as there was in 1975.

Mortality of understory trees, top kill, and branch dieback on all age classes and cone damage is evident in many Douglas-fir stands on all six National Forests.

Table 3.--Comparison of predicted and actual defoliation in 1975 on Helena egg mass plots.

Plot name	Plot location	Predicted defoliation for 1975 (%)	Current defoliation in 1975 (%)	Predicted defoliation in 1976 (%)
Greyson Creek	T. 6N., R.4E., Sec. 24	65	81.0+	62
Hay Creek	T. 6N., R.5E., Sec. 9	51	81.0+	45
Cabin Gulch	T. 7N., R.4E., Sec. 12	65	78.9	73
Deep Creek	T. 7N., R.5E., Sec. 22	19	81.0+	25
S. of Elliston	T. 9N., R.6W., Sec. 30	49	81.0+	67
White Gulch	T.10N., R.2E., Sec. 1	65	81.0+	48
Mullan Pass	T.10N., R.6W., Sec. 2	38	81.0+	39
Magpie Creek	T.11N., R.1E., Sec. 3	60	81.0+	45
Marsh Creek	T.12N., R.7W., Sec. 1	30	74.9	58
Nevada Creek	T.12N., R.8W., Sec. 22	26	50.7	20
Indian Creek	T.12N., R.1E., Sec. 7	67	81.0+	27
Pike Creek	T.13N., R.1E., Sec. 30	76	81.0+	57
Virginia Cr.	T.13N., R.7W., Sec. 12	11	16.9	5
Flesher Pass	T.14N., R.6W., Sec. 15	21	67.1	75
Canyon Creek	T.14N., R.6W., Sec. 34	33	81.0+	73

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